



NIMA Library Storage Requirements for Video

Video Archive and Dissemination



Overview

- **Objective**
- **Video Architectures**
- **Approach**
- **Definitions**
- **Operational Considerations**
- **Assumptions**
- **Estimation Methodology**
- **Purge Concept**
- **Storage Requirements**



NIMA Library Storage Requirements Developmental Objective

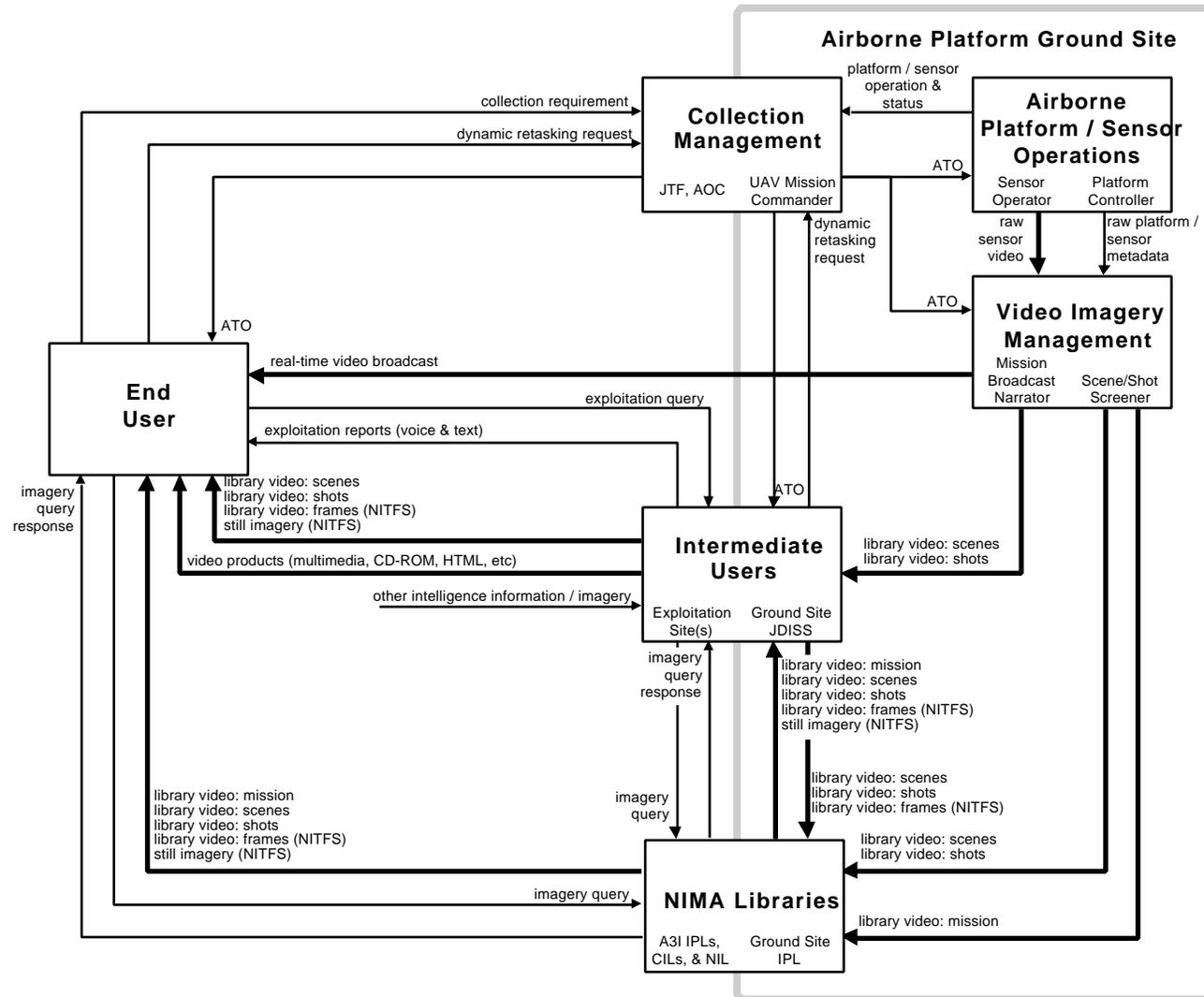
“Bound” video storage and estimate video storage requirements

- **Conservative estimate**
 - Limits requirements growth
 - Practical requirements only
- **Incorporate**
 - Emerging VWG Standards Architecture Document
 - Core Video Metadata Standard
- **Consider**
 - Notional CONOPS and Users’ Interview responses
 - Video image quality requirements
 - Video exploitation requirements
 - Existing and planned video system architectures
- **Apply pragmatic technical and systems judgment**



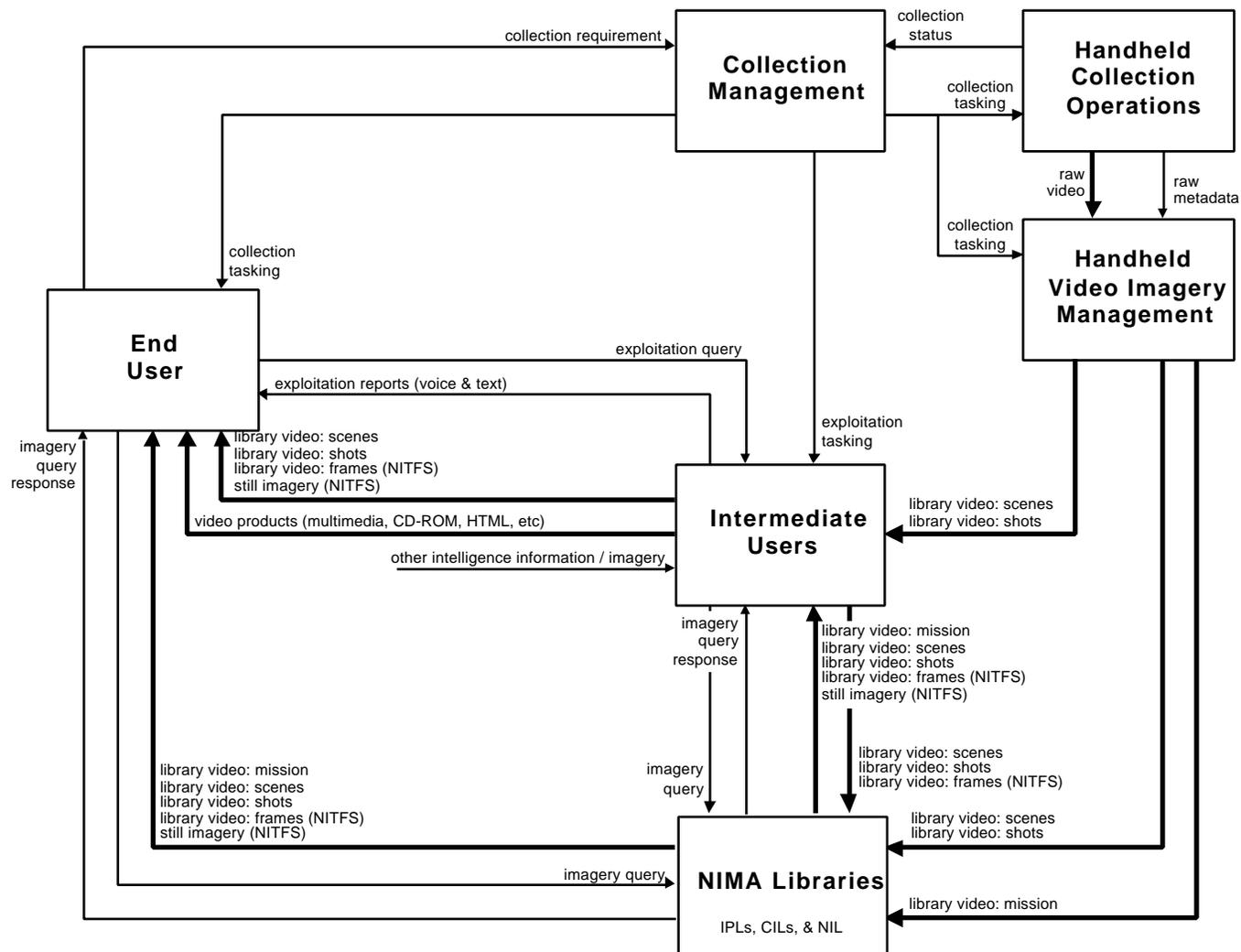
UAV Video

Video Imagery Architecture





Handheld Video Video Imagery Architecture



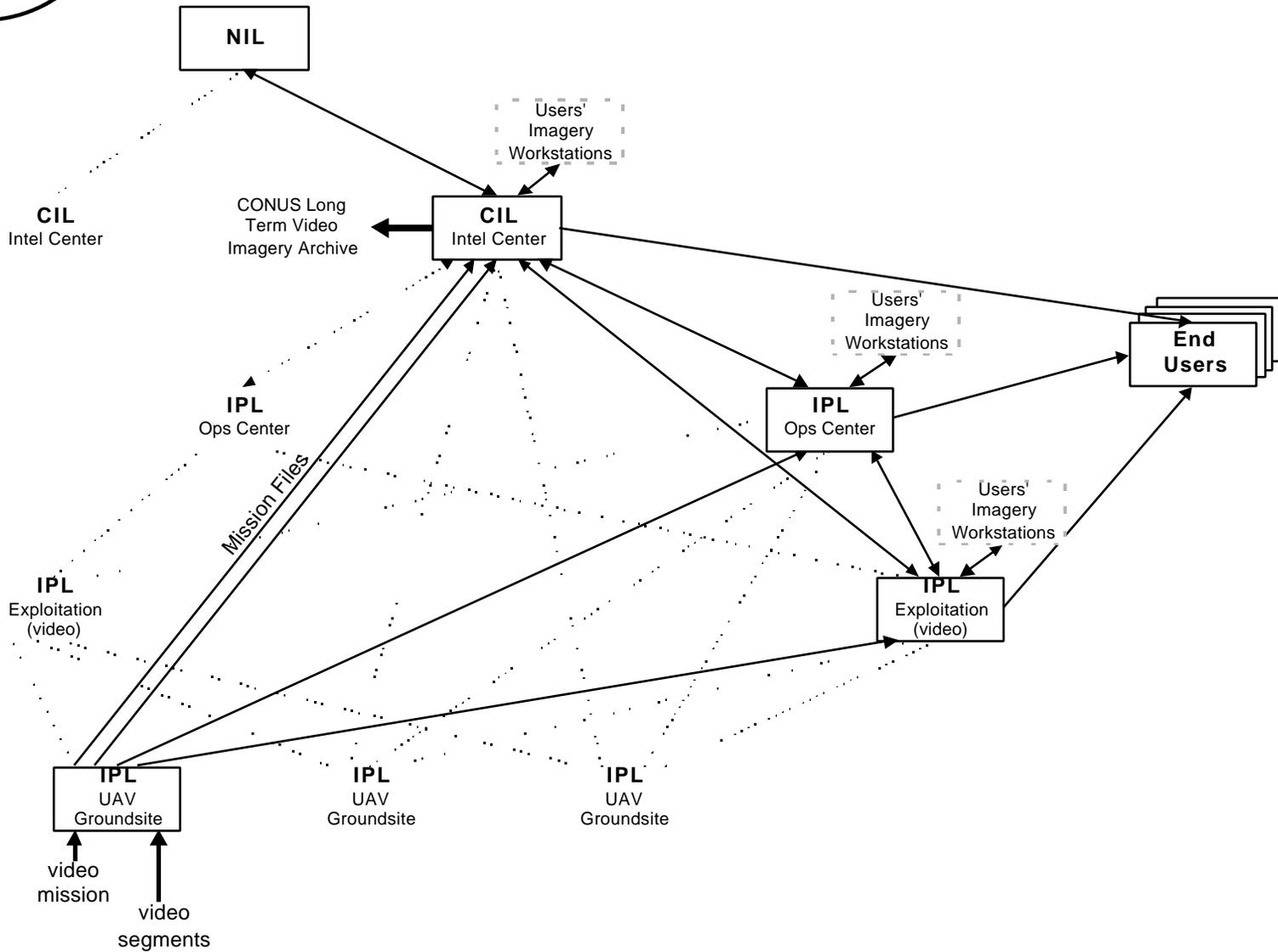


Storage Requirements Approach

- **Review**
 - NIMA Library concepts
 - Video Imagery Concept of Operations
 - VWG Standards Architecture
 - Performance of sensor and datalink
 - Users' operational mission
 - Tasking by collection management authority
 - Ad hoc tasking
 - Others?
- **Formulate Operational Considerations**
- **Determine assumptions**
- **Develop storage requirements**



Notional Video Library Hierarchy





Definitions

- **Mission cycle** - describes typical duration of user's operational mission timeframe and determines "half-life" of imagery for purging
- **Working imagery** - supports daily operations within a library and subject to automatic purging or transfer
- **Mission critical imagery** - specific portion of storage capacity used for local storage of mission critical video imagery. Not subject to automatic purging or transfer



UAV Groundsite IPL Operational Considerations

- **Deployable**
- **Stages all video segments for dissemination to other libraries for exploitation and archive**
- **Stages mission video for transfer to CIL**
- **Prepares video imagery for dissemination**
 - 144 video segments @ 5 min with intel content
 - 144 video segments @ 5 min not associated with intel content
- **Single UAV video sensor operating 24 hrs per day**
 - Video imagery mission cycle of 12 hours



UAV Groundsite IPL Operational Considerations

(continued)

- **“Buffers” imagery for post-real-time dissemination to exploiters**
 - “Pushes” to specified exploitation site per profiles
 - Notifies profiled recipients
 - Supports query, browse, and retrieve
- **Manages video mission imagery**
 - **Builds complete video mission “files” (24 hours per day)**
 - Fully indexed on library for full search, query, browse, and retrieval
 - **Transfers mission video imagery to CIL**
 - Complete missions transferred after 10 days (Estimate 16 tapes per 24 hour mission)
- **Retains mission critical imagery equivalent to the imagery input in one mission cycle**



Video Exploitation Center IPL Operational Considerations

- **Deployable**
- **Short-term repository for video imagery segments and imagery products**
- **Supports equivalent to 1 UAV video sensor 24 hours per day**
 - Video imagery mission cycle of 24 hours
 - Exploit 144 video segments @ 5 min
 - Exploit segments having intel content
 - Pushed from UAV groundsite IPL
 - Query, browse, and retrieve
- **IPL supplies imagery to users' imagery workstations**



Video Exploitation Center IPL Operational Considerations

(continued)

- **Reference other video imagery as needed**
 - Other video imagery segments on UAV groundsite IPL
 - Mission video on UAV groundsite IPL
 - Video Imagery segments on other libraries
 - Equivalent to 15 video segments @ 5 min
- **Receive exploitation reports and secondary video imagery from Operations Center IPL and CIL**
- **Build secondary video imagery products**
 - 144 video segments @ 30 sec
- **Retain mission critical imagery equivalent to the imagery input in two mission cycles**



Operations Center IPL Operational Considerations

- **Medium-term repository for video imagery products and selected video imagery**
- **Responsible for Theater operations**
- **Manages video imagery products to support current operations**
 - Video imagery mission cycle of 10 days
- **Supported by equivalent of 3 video sensors operating 24 hours per day and associated exploitation**
- **Exploit video imagery collected in responses to operations center tasking**
 - 45 video segments @ 5 min per day (15 segments per UAV)



Operations Center IPL Operational Considerations

(continued)

- **Employ video imagery products from UAV video exploitation centers**
 - 432 video segments @ 30 sec per day (144 segments from each of 3 UAVs)
 - 8 video segments @ 30 sec per day from CIL
- **IPL supplies imagery to users' imagery workstations**
- **Retain mission critical imagery equivalent to the imagery input in two mission cycles**



Command Imagery Library (CIL) Operational Considerations

- **Broad holdings of national imagery of interest to command**
- **Broad holdings of tactical video imagery products having long term value to command's mission**
- **Video imagery mission cycle of 100 days**
- **Brokers command's external imagery needs**
 - Requests for NIL imagery
 - Requests for imagery from other CILs
- **Maintain mission video library**
 - Complete 24 hour missions
 - Fully indexed allowing full search, query, browse, and retrieval
 - Transfer to CONUS archive after 100 days



CIL

Operational Considerations

(continued)

- **Exploit video imagery collected in responses to command tasking**
 - 3 UAVs operating 24 hours per day
 - 120 min per day (8 video segments @ 5 min per day per UAV)
- **Employ video imagery products from operations centers and UAV video exploitation centers**
 - 432 video segments @ 30 sec per day (144 segments from each of 3 UAV video exploitation centers)
 - 135 video segments @ 30 sec per day (45 segments from each of 3 operations centers)
- **Retain mission critical imagery equivalent to the imagery input from two mission cycles**



CIL

Storage Assumptions

Video storage requirements as a percentage of applicable tactical video available to the “command”

ACOM	100%
CENTCOM	100%
PACOM	100%
EUCOM	100%
STRATCOM	25%
NAIC	10%
DIAC	120%
Pentagon	12%
PID	120%
480th IG	24%
IAG	70%



National Imagery Library (NIL)

Operational Considerations

- **Commands forward selected tactical imagery**
- **Video imagery mission cycle of 1 year**
- **Video imagery is typically gathered to support tactical missions**
 - **Tactical video tends to have short “shelf life”**
 - **Some tactical UAV video imagery will have content required for national missions**



NIL

Assumptions

- **Video imagery products have content of potential national significance**
 - Two MRCs supported by two commands
 - 6 UAV's operating 24 hours per day by
 - 120 min per day from UAVs (20 min per day per UAV)
 - Video imagery transferred to NIL from CILs
- **Equivalent amount of video imagery from other sources has content of national significance**
 - Handheld cameras
 - Gun cameras
 - other
- **Retain mission critical imagery equivalent to the imagery input in 3.1 mission cycles (results in 5 year equivalent)**



Assumptions

- **NIMA Libraries accept and output video imagery in library video format IAW VWG Standards Architecture Document**
 - **Defines “Video Quality” (VQ) profiles having range of quality, compression, and bandwidth requirement**
 - **NIMA library video formats integrate**
 - Video imagery
 - Video imagery metadata
 - Audio
- **All NIMA Library users and operators perform processing to provide video imagery data in standard library video format**



Video Performance Estimation Methodology

- **Analysis focuses on a single video sensor imagery thread**
 - Stripped of all interactions beyond the single sensor imagery flow
- **Includes non-dimensional video imagery loading factor for each library interface**
 - Factor of 1.0 is 24 hours of streaming video imagery
 - All other factors are linear fractions of the input
- **Extrapolate to support video imagery flow for multiple video sensor imagery threads**
- **Develop purge concept**
- **Need to add results to still imagery storage requirements**

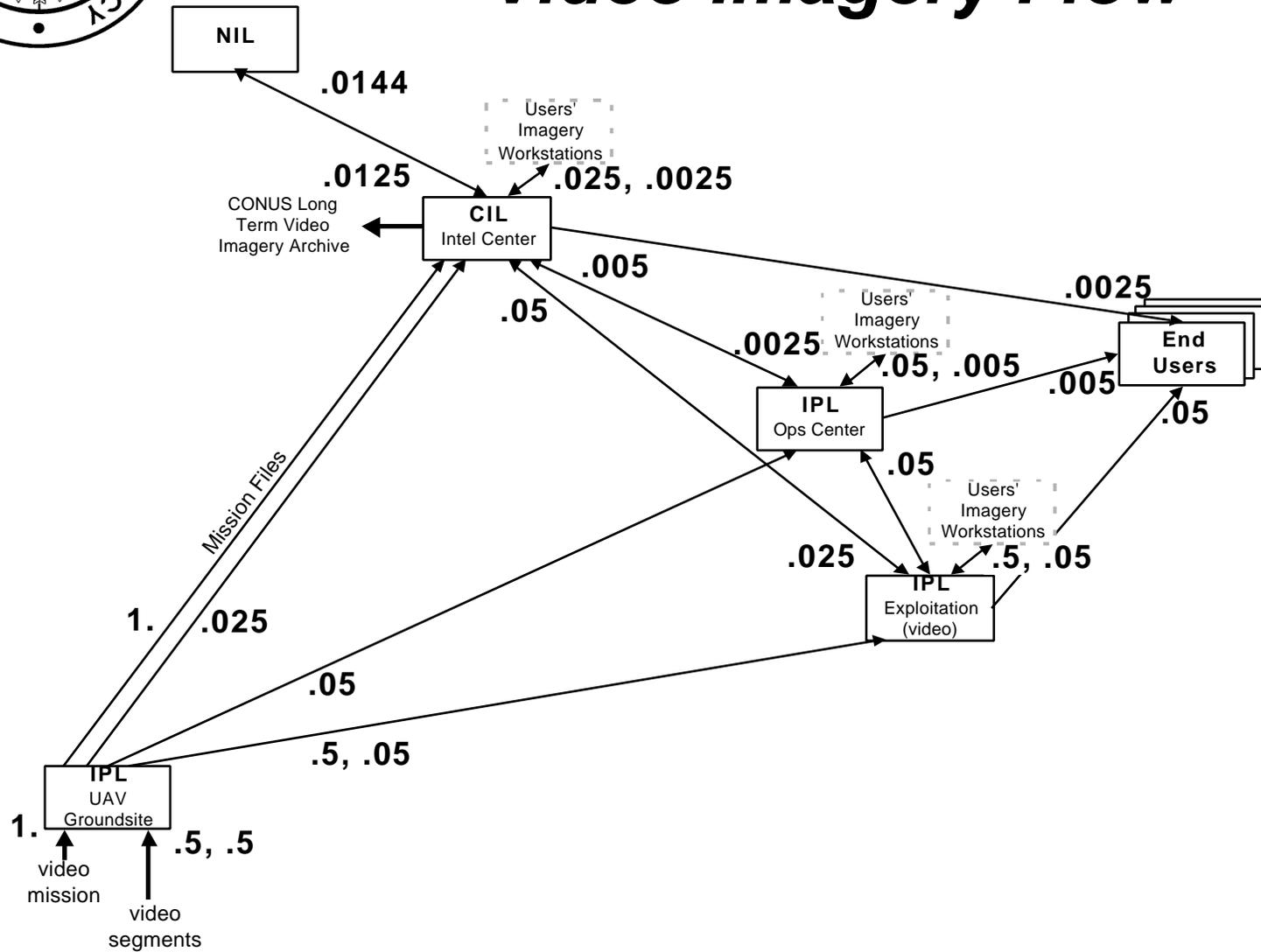


Purge Concepts

- **Each library's operational timeframe determines the “half-life” of the working imagery on that IPL**
 - After one mission cycle, 50% of the imagery is purged or transferred (50% remains)
 - After two mission cycles, an additional 50% is purged or transferred (25% remains)
 - After three mission cycles, an additional 50% is purged or transferred (12.5% remains)
 - After fourth mission cycles remaining working imagery is purged or transferred to mission critical imagery
- **Implementation is responsibility of the library user's command**



Storage Estimation Video Imagery Flow





UAV Groundsite IPL Storage Estimation

Imagery Half-Life	0.5	Video Factor	1.0000	Number Sensors	1
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Estimated Storage Capacity Current Mission Tasking			VQ3	VQ4	VQ5	VQ6	VQ7
			1.5 Mb/s	6 Mb/s	20 Mb/s	55 Mb/s	270 Mb/s
Archive	Video Factor	hours	GB/h	GB/h	GB/h	GB/h	GB/h
Data Rate	1.00	1	0.7	3	9	25	122
			GB	GB	GB	GB	GB
1st Mission Cycle	1.00	12	8	32	108	297	1,458
1st Purge	0.50	6	4	16	54	149	729
2nd Purge	0.25	3	2	8	27	74	365
3rd Purge	0.13	2	1	4	14	37	182
Mission Critical	1.00	12	8	32	108	297	1,458
TOTAL	2.88	35	23	93	311	854	4,192

Estimated Storage Capacity Full Mission Archive			VQ3	VQ4	VQ5	VQ6	VQ7
			1.5 Mb/s	6 Mb/s	20 Mb/s	55 Mb/s	270 Mb/s
		Video Factor	GB	GB	GB	GB	GB
		days	GB	GB	GB	GB	GB
		1.00	81	324	1,080	2,970	14,580



UAV Groundsite IPL Storage Estimation

(continued)

Estimated I / O Capacity External Library Interfaces			Sensor	IPL	Dissem	Sensor	IPL	Dissem
			VQ4	VQ5	VQ3	VQ5	VQ6	VQ3
			6 Mb/s	20 Mb/s	1.5 Mb/s	20 Mb/s	55 Mb/s	1.5 Mb/s
			MB/s	MB/s	MB/s	MB/s	MB/s	MB/s
Sensor: Segments	Input	1	0.75			2.50		
Sensor: Mission	Input	1	0.75			2.50		
IPL: Exploitation (video)	Output	0.55		1.38			3.78	
IPL: Operations Center	Output	0.05		0.13			0.34	
CIL: Segments	Output	0.025		0.06			0.17	
CIL: Mission	Output	1		2.50			6.88	
TOTAL	I/O	3.625	1.50	4.06	0.00	5.00	11.17	0.00
GRAND TOTAL			5.56			16.17		



Video Exploitation Center IPL Storage Estimation

Imagery Half-Life	1	Video Factor	0.6250	Number Sensors	1
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Estimated Storage Capacity Current Mission Tasking			VQ3 1.5 Mb/s	VQ4 6 Mb/s	VQ5 20 Mb/s	VQ6 55 Mb/s	VQ7 270 Mb/s
Archive Data Rate	Video Factor	hours	GB/h	GB/h	GB/h	GB/h	GB/h
	1.00	1	0.7	3	9	25	122
1st Mission Cycle	1.00	15	10	41	135	371	1,823
1st Purge	0.50	8	5	20	68	186	911
2nd Purge	0.25	4	3	10	34	93	456
3rd Purge	0.13	2	1	5	17	46	228
Mission Critical	2.00	30	20	81	270	743	3,645
TOTAL	3.88	58	39	157	523	1,439	7,062



Video Exploitation Center IPL Storage Estimation

(continued)

Estimated I / O Capacity External Library Interfaces			Sensor	IPL	Dissem	Sensor	IPL	Dissem
			VQ4	VQ5	VQ3	VQ5	VQ6	VQ3
			6 Mb/s	20 Mb/s	1.5 Mb/s	20 Mb/s	55 Mb/s	1.5 Mb/s
			MB/s	MB/s	MB/s	MB/s	MB/s	MB/s
IPL: UAV	Input	0.5		1.25			3.44	
IPL: UAV other	Input	0.05		0.13			0.34	
IPL: Operations Center	Input	0.05		0.13			0.34	
CIL: Segments	Input	0.0025		0.01			0.02	
Exploitation workstations	Input	0.05		0.13			0.34	
Exploitation workstations	Output	0.5		1.25			3.44	
IPL: Operations Center	Output	0.05		0.13			0.34	
CIL: Segments	Output	0.05		0.13			0.34	
End User	Output	0.05			0.01			0.01
TOTAL	I/O	1.3025	0.00	3.13	0.01	0.00	8.61	0.01
GRAND TOTAL				3.14			8.62	



Operations Center IPL Storage Estimation

Imagery Half-Life	10	Video Factor	0.1250	Number Sensors	3
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Estimated Storage Capacity			VQ3	VQ4	VQ5	VQ6	VQ7
Current Mission Tasking			1.5 Mb/s	6 Mb/s	20 Mb/s	55 Mb/s	270 Mb/s
Archive	Video Factor	hours	GB/h	GB/h	GB/h	GB/h	GB/h
Data Rate	1.00	1	0.7	3	9	25	122
1st Mission Cycle	1.00	90	61	243	810	2,228	10,935
1st Purge	0.50	45	30	122	405	1,114	5,468
2nd Purge	0.25	23	15	61	203	557	2,734
3rd Purge	0.13	11	8	30	101	278	1,367
Mission Critical	2.00	180	122	486	1,620	4,455	21,870
TOTAL	3.88	349	235	942	3,139	8,632	42,373



Operations Center IPL Storage Estimation

(continued)

Estimated I / O Capacity External Library Interfaces			Sensor	IPL	Dissem	Sensor	IPL	Dissem
			VQ4 6 Mb/s MB/s	VQ5 20 Mb/s MB/s	VQ3 1.5 Mb/s MB/s	VQ5 20 Mb/s MB/s	VQ6 55 Mb/s MB/s	VQ3 1.5 Mb/s MB/s
IPL: Exploitation (video)	Input	0.05		0.13			0.13	
IPL: UAV	Input	0.05		0.13			0.13	
CIL: Segments	Input	0.0025		0.01			0.02	
Exploitation workstations	Input	0.25		0.63			1.72	
Exploitation workstations	Output	0.025		0.06			0.17	
IPL: Exploitation (video)	Output	0.025		0.06			0.17	
CIL: Segments	Output	0.005		0.01			0.03	
End User	Output	0.005			0.0009			0.0009
TOTAL	I/O	0.4125	0.00	1.02	0.00	0.00	2.36	0.00
GRAND TOTAL				1.02			2.37	



CIL Storage Estimation

Imagery Half-Life	100	Video Factor	0.1125	Number Sensors	3
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Estimated Storage Capacity Current Mission Tasking				VQ3	VQ4	VQ5	VQ6	VQ7
				1.5 Mb/s	6 Mb/s	20 Mb/s	55 Mb/s	270 Mb/s
Archive	Video Factor	hours		GB/h	GB/h	GB/h	GB/h	GB/h
Data Rate	1.00	1		0.7	3	9	25	122
				GB	GB	GB	GB	GB
1st Mission Cycle	1.00	810		547	2,187	7,290	20,048	98,415
1st Purge	0.50	405		273	1,094	3,645	10,024	49,208
2nd Purge	0.25	203		137	547	1,823	5,012	24,604
3rd Purge	0.13	101		68	273	911	2,506	12,302
Mission Critical	2.00	1,620		1,094	4,374	14,580	40,095	196,830
TOTAL	3.88	3,139		2,119	8,475	28,249	77,684	381,358

Estimated Storage Capacity Full Mission Archive				VQ3	VQ4	VQ5	VQ6	VQ7
				1.5 Mb/s	6 Mb/s	20 Mb/s	55 Mb/s	270 Mb/s
		Video Factor	days	GB	GB	GB	GB	GB
		1.00	90	1,458	5,832	19,440	53,460	262,440



CIL

Storage Estimation

(continued)

Estimated I / O Capacity External Library Interfaces			Sensor VQ4 6 Mb/s MB/s	IPL VQ5 20 Mb/s MB/s	Dissem VQ3 1.5 Mb/s MB/s	Sensor VQ5 20 Mb/s MB/s	IPL VQ6 55 Mb/s MB/s	Dissem VQ3 1.5 Mb/s MB/s
IPL: Exploitation (video)	Input	0.05		0.13			0.34	
IPL: UAV	Input	0.025		0.06			0.17	
IPL: UAV Missions	Input	1		2.50			6.88	
Exploitation workstations	Input	0.25		0.63			1.72	
NIL: Reference magery	Input	0.0125		0.03			0.09	
NIL: Products	Output	0.05		0.13			0.34	
Exploitation workstations	Output	0.0025		0.01			0.02	
IPL: Exploitation (video)	Output	0.0025		0.01			0.02	
IPL: Operations Center	Output	0.0025		0.01			0.02	
End User	Output	0.0025			0.0005			0.0005
TOTAL	I/O	1.3975	0.00	3.49	0.00	0.00	9.59	0.00
GRAND TOTAL				3.49			9.59	



NIL Video Storage Estimation

Imagery Half-Life	365	Video Factor	0.0144	Equiv # of Sensors	12
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Estimated Storage Capacity			VQ3	VQ4	VQ5	VQ6	VQ7
Current Mission Tasking			1.5 Mb/s	6 Mb/s	20 Mb/s	55 Mb/s	270 Mb/s
Archive	Video Factor	hours	GB/h	GB/h	GB/h	GB/h	GB/h
Data Rate	1.00	1	0.7	3	9	25	122
			GB	GB	GB	GB	GB
1st Mission Cycle	1.00	1,514	1,022	4,087	13,624	37,465	183,918
1st Purge	0.50	757	511	2,044	6,812	18,732	91,959
2nd Purge	0.25	378	255	1,022	3,406	9,366	45,979
3rd Purge	0.13	189	128	511	1,703	4,683	22,990
Mission Critical	3.13	4,730	3,193	12,772	42,574	117,077	574,744
TOTAL	5.00	7,569	5,109	20,435	68,118	187,324	919,590